

**Noise level in neonatal intensive care unit\****Nível de ruído em unidade de terapia intensiva neonatal**Nivel de ruido en una unidad de cuidados intensivos neonatal***Tereza Yoshiko Kakehashi<sup>1</sup>, Eliana Moreira Pinheiro<sup>2</sup>, Gilberto Pizzarro<sup>3</sup>, Arnaldo Guilherme<sup>4</sup>****ABSTRACT**

**Objectives:** Determine noise levels in the Neonatal Intensive Care Unit and identify the sources of these noises. **Methods:** Quantitative, descriptive and exploratory study, carried out in São Paulo. Data was collected in April and May of 2005. A dosimeter was used to record a total of 96 hours of measurements. Nine hours of observation were also conducted to identify sources of noise. **Results:** Leq noise levels ranged from 61.3 to 66.6 dBA and were higher on the weekends. Peak values ranged from 90.8 to 123.4 dBC and the highest values were recorded at night. The sources of the noise were: beeping noises from ventilators and heart rate monitors, conversations between health professional and others. **Conclusion:** The deleterious effects of high levels of noise on newborns and health professionals show the need for interventions in routines and professionals and families' conduct.

**Keywords:** Noise; Noise measurement; Intensive care, neonatal; Neonatal nursing; Infant, newborn

**RESUMO**

**Objetivo:** Verificar o nível de ruído da Unidade de Terapia Intensiva Neonatal e identificar suas fontes. **Métodos:** Estudo quantitativo, descritivo e exploratório, conduzido em uma Unidade de Terapia Intensiva Neonatal de São Paulo. A coleta de dados ocorreu de abril a maio de 2005, utilizando um dosímetro para 96 horas de registro do nível de pressão sonora e 9 horas de observação, para identificar as fontes de ruído. **Resultados:** Registrou-se Leq entre 61,3 a 66,6 dBA, sendo maior nos dias do final de semana. Os valores dos picos variaram de 90,8 a 123,4 dBC, sendo mais elevados no período noturno. As principais fontes foram: alarme dos ventiladores, dos oxímetros, conversa entre profissionais e pais e outros. **Conclusão:** Considerando os efeitos deletérios do nível elevado de ruído sobre neonatos e equipe de saúde, os resultados demonstram a necessidade de intervenções em algumas rotinas e na conduta dos profissionais e familiares.

**Descritores:** Ruído; Medição de ruído; Terapia intensiva neonatal; Enfermagem neonatal; Recém-nascido

**RESUMEN**

**Objetivo:** Verificar el nivel de ruido de la Unidad de cuidados Intensivos Neonatal (UCIN) e identificar sus fuentes. **Métodos:** Fue conducido en una Unidad de Cuidados Intensivos Neonatal de Sao Paulo. Se trata de un estudio cuantitativo, descriptivo y exploratorio. La recolección de datos ocurrió de abril a mayo del 2005, utilizando un dosímetro para 96 horas de registro del nivel de presión sonora y 9 horas de observación, para identificar las fuentes del ruido. **Resultados:** Se registró Leq entre 61.3 a 66,6 dBA, siendo mayor en los días del final de semana. Los valores de los picos variaron de 90,8 a 123,4 dBC, siendo más elevados en el período nocturno. Las principales fuentes fueron: alarma de los ventiladores, de los oxímetros, conversación entre profesionales y padres y otros. **Conclusión:** Considerando los efectos deletérios del nivel elevado de ruido sobre neonatos y el equipo de salud, los resultados demuestran la necesidad de intervenciones en algunas rutinas y en la conducta de los profesionales y familiares.

**Descriptores:** Ruido; Medición de ruido; Cuidados Intensivos Neonatal; Enfermería neonatal; Recién nacido

\* Study performed at a Public University Hospital in the City of São Paulo – São Paulo (SP), Brazil.

<sup>1</sup> DNS, Professor at São Marcos University, São Paulo (SP), Brazil.

<sup>2</sup> DNS, Adjunct Professor at the Federal University of São Paulo – UNIFESP – São Paulo (SP), Brazil.

<sup>3</sup> Physician of the Otorhinolaryngology Department at Federal University of São Paulo – UNIFESP - São Paulo (SP), Brazil

<sup>4</sup> PhD, Adjunct Professor of the Otorhinolaryngology Department at Federal University of São Paulo – UNIFESP - São Paulo (SP), Brazil

## INTRODUCTION

There is scientific evidence that the fetus is able to hear from the 5<sup>th</sup> month on<sup>(1)</sup> and even though the main ear structures have already developed at the 25th week of pregnancy, they will be adult size one year after birth<sup>(2)</sup>.

Inside the Neonatal Intensive Care Unit (UTIN) there are different kinds of noise such as fans, incubators, monitors, alarms, secretion evacuators, oxygen and compressed air escapes, telephones, conversations between health workers and relatives which can interfere with the baby's well-being and harm his/her development. Kinds of disorganized sound and in frequencies physiologically incompatible with the human ear that can cause physical lesions and psychic and behavioral changes are considered types of noise<sup>(3, 4)</sup>. Environmental noise is usually incidental, not chosen and there is no control of volume, duration, location or cause/effect relation<sup>(5)</sup>.

The newborn can't interfere with the environmental noise, but his/her behavioral ability allows him/her to show if he/she is comfortable or not and that can influence the professionals to make some environmental changes in order to soften sound aggressions.

By watching the routine in neonatal units we noticed that the health team is concerned about monitoring newborns' physiologic parameters as well as regulating the equipment, but they are not worried about systematically evaluating environmental ecology. Literature points out that care practices are toward the "victims" of environmental inadequacy, with no pro-active attitude to assure better hospital ecology<sup>(6)</sup>. In this context, NICU workers should try to establish strategies to take care of the newborn's development, employing procedures that minimize adverse environmental stimuli such as extreme noise.

Concerns about the environment also regards the humanization of care in order to welcome and respect the patient by joining together proper work place and the best technology available for good technical practices and satisfaction of health professionals and user<sup>(7)</sup>.

The patient can recover earlier and the team can experience less stress and tiredness and improve their working capacity in a hospital setting with reasonable noise levels<sup>(8)</sup>.

A study in a NICU, in the city of Ribeirão Preto, São Paulo state, in 2004 found levels of sound pressure of continuous noise between 48.6 dBA and 88.3 dBA and impact noise up to 114.1 Dbc<sup>(9)</sup>.

The American Academy of Pediatrics suggests that Neonatal Units should develop routine procedures and environmental noise monitoring so that noise can be bellow 45 dBA<sup>(10)</sup>.

As professors at hospital schools, where the physical space plan, maintenance of equipments, number of professionals, patients, and relatives are not always appropriate, and based on the deleterious effects described in the literature, we wonder what noise levels newborns and professionals are exposed to. Would noise levels be within the recommended levels by the control agencies? What are the main sources of noise and how could we interfere in them? Could there be any difference in noise levels in relation to the days of the week and to different times of the day because of routine and the number of professionals working in the unit?

Thus, considering all those aspects, the goals of this study were to check noise levels in the NICU setting at a hospital school, which is managed by a public university in a city in São Paulo state as well as identify the noise sources.

## METHODS

It is a quantitative, descriptive and exploratory study.

The study was conducted in a NICU at a public university hospital school in São Paulo state, where undergraduate and graduate students in Nursing and Medical schools have their internship programs. That unit is 18m<sup>2</sup> big, with 2.5m high and has vinyl-covered floor, brick walls and cardboard-like gesso ceiling. There is a 13.5 cm deep stainless steel sink in a front room. On that sink there is a faucet which is 31cm far from the bottom of the sink. There is a counter where necessary materials are kept and next to it there is a plastic wastebasket with a pedal to open it. There is enough space for six incubators but sometimes the population demand is more than that. In the corridor, next to the NICU entrance door, there is a counter and a telephone where the medical prescriptions take place.

The data were collected from April 28<sup>th</sup>, 2005 at 7:00 a.m. to May 2<sup>nd</sup>, 2005 at 6:59 a.m.. Because of staff shift, the period between 07:00 P.M and 06:59 of the following day was considered data collection day. A 706 Spark<sup>R</sup> dosimeter, previously regulated by Inmetro, was used. That equipment measures sound pressure levels in decibels (dB)<sup>11\*</sup> and it is made of electronic circuits; it works as a chronometer, a calculator, and database as well. It works on a 100 hour battery and then it was possible to collect data with no breaks. Therefore, the duration of each noise level was precisely registered and stored and the researcher had a set of data for statistical treatment and analysis.

Scales A and C under fast mode were used to register the data because that speed makes it possible to measure kinds of noise that do not oscillate rapidly.

Scale A (dBA), is the filtering method that simulates

\* Decibel: relative intensity measure to evaluate noise levels, its reference is in logarithmic scale 11

the receptive characteristics of the human ear and it is recommended to capture continuous noise (Leq); scale C measures impact noise (Lpeak)<sup>(12)</sup>.

A microphone was hung on the ceiling to measure environmental noise; it was 1.6m away from the floor and 1.0 m away from the wall so that it could not be hit or shaken<sup>(13)</sup>. The equipment was on for 72 hours and the researcher who collected data was in there sporadically because people might control their voice tone because of the equipment and the researcher's presence. The desensitization period was 72 hours because the constant analysis of the data recorded by the dosimeter compared with those from observation showed higher sound pressure levels even when there were not any alarms, equipment being used, faucets running, telephones ringing, and more people in the room. Those records and the data collected during observation concluded that such increase was caused by people's higher voice tone, which characterizes people adopting their usual behavior. At the same time, one of the team's researcher verified, after that period, people were returning to their usual behavior. At that time, the researchers noticed that there were some differences in sound pressure levels during the days of the week and on weekends.

Therefore, due to the cost of equipment leasing, the data were collected on Thursday and Friday, Saturday and Sunday, and the dosimeter was on for 96 hours. During that period, there were 5760 recordings and they were enough for the analysis and comprehension of the phenomenon.

In addition to that, a researcher was in the unit on Thursday, Friday and Sunday at different times of the day: 1 hour in the morning, one hour in the afternoon and one hour at night. Overall, there were 9 hours of observation in order to identify the noise sources. The observation times were settled according to the number of week days and the number of weekends, proportionally (Chart 1), and recording sound pressure level at the beginning, in the middle and at the end of the three work shifts, based on the changes in routines during different times of the day, such as, doctors shift, performance of exams and procedures, doctor, parents and relatives' visit, parents' hearing and clinical discussion.

Observation was not structured and the recordings were chronicled in a journal where time and minute of

noise occurrence as well as its source were written down. Both continuous and impact noise types were registered. Before starting observation, the researcher took note of the number of new borns, professionals, working equipments such as fans, oxymeters and infusion pumps in the unit. The researcher also registered changes in those data and other events during observation, such as electricity outages.

The Ethics in Research Committee had approved the project according to its ethics principles based on the CNS n.º 196/96 Resolution before data collection started. Authorization by the hospital Management where the research was performed was also requested.

Descriptive statistical analysis was performed in order to understand the results, focusing the variation of sound levels during the three different periods of the weekdays, identifying the peak (L peak) and the integrated medium sound pressure (Leq). Leq is an important datum to analyze the results of this study, once it makes knowing the integrated medium sound level during a specific period of time possible, which is important because human hearing lesions are caused not only by a high sound level but also by its duration<sup>(14)</sup>.

The data from the researcher's observation were correlated in the analysis with the sound level from the dosimeter in different moments.

## RESULTS

There were four pre term newborns in incubators using infusion pumps and wrist oxymeter during data collection. Only three babies had artificial respiration and they were evacuated when it was necessary. On average, there were two nursing assistants during the observation period. The nurse who was in charge of the nursery went to the NICU sporadically. The medical team was in the unit during regular rounds to examine the babies and help the families. There were no students because it was school break time. Parents were allowed to stay with their children in the unit from 7:00 a.m. to 7:00 p.m. The X-Ray technician was there only sporadically and so was the Gas Analysis technician to evaluate gas piping conditions.

Under those conditions, the recordings confirmed the following sound levels during different days of the week: on Thursday, Leq was 62.2 dBA and Lpeak oscillated

**Chart 1** – schedule for noise source observation in UTIN

Days of the week / after-hour care	Thursday	Friday	Sunday
Morning	7:00 – 7:59	9:00 – 9:59	11:00 – 11:59
Afternoon	1:00 – 1:59	3:00 – 3:59	5:00 – 5:59
Night	7:00 – 7:59	0:00 a.m. – 0:59 a.m.	6:00 a.m – 6:59 a.m.

from 96.8 to 121.0 dBC; on Friday, Leq was 61.3 dBA and L<sub>peak</sub> oscillated from 90.8 to 100.3 dBC; on Saturday, Leq was 66.0 dBA and L<sub>peak</sub> oscillated from 98.9 to 123.4 dBC; on Sunday, Leq was 66.6 dBA and L<sub>peak</sub> oscillated from 103.4 to 107.6 dBC.

The results showed that levels of continuous sound pressure (Leq) recorded on weekends were higher than the ones on Thursday and Friday. Although Leq value on different days of the week was similar, the sound pressure level was proportional to sound intensity measured in a logarithmic scale.

Although Leq values on different days of the week were close, the sound pressure level was proportional to the sound intensity that was measured using a logarithmic scale where a 3dB increase is the same as the double of the sound energy produced<sup>(11)</sup>. The data showed that impact noise peaks (L<sub>peak</sub>) during the night (123.4 dBC) were higher than in the morning (103.4 dBC) and in the evening (90.8 dBC). However, it was not possible to correlate those peaks to their sources, since they occurred when the observer was absent. It is important to say that 123.4 dB is close to the pain tolerance threshold (125.0 dB)<sup>(12)</sup>.

According to the recordings, the main events related to increased sound pressure were: the alarm of the fans and the wrist oxymeters (111.5 dBC); conversation between professionals (99.9 dBC) and parents (107.6 dBC), the machine used to clean the floor of the unit (101.5 dBC); the sound of the water from the sink faucet where people wash their hands in the front room, the sound of the waste basket lid, and tearing open the packaging of some disposable materials were also significant for the increase of sound pressure. Besides, professionals cutting tissue to dry their hands also represented a sound source. It is important to say that those sound events are not isolated. The reports showed that those sources, together with alarms and conversation among employees increased the sound pressure to 123.4 dBC.

## DISCUSSION

The results showed that the sound levels were over those recommended by the WHO- that is, Leq inside the hospitals, during the day, at 40 dB at most, at night the sound pressure should be from 5 to 10 dB<sup>(15)</sup>. The American Academy of Pediatrics suggests NPS up to 45 dB for Pediatrics and Neonatology<sup>(9)</sup>. NPS limits suggested for NICUs by the Committee to Establish Recommended Standards for Newborn ICU Design of Florida – USA, are from 45 to 50 measured in slow scale<sup>(16)</sup>. The Brazilian Association of Technical Rules suggests keeping the sound pressure between 35 and 45 dB<sup>(17)</sup> in the nursery.

A study in a NICU at the University of São Paulo Hospital in Ribeirão Preto confirmed high NPS and Leq between 49.9 dBA and 88.3 dBA and impact sound up to 114.1 dBC<sup>(8)</sup>.

The data recorded evidenced a higher Leq on the weekend. That event opposed the researchers' expectations, because more professionals are required and more procedures are performed in everyday routine. Based on the study at the university hospital in Ribeirão Preto – São Paulo, it was possible to verify that there were not any significant differences between NPS on the week days and on the weekend<sup>(8)</sup>. Another study showed that NPS on Saturday is higher<sup>(18)</sup>.

There were no any emergency events during data collection that could justify the increase of noise levels in the unit, thus it is assumed that there was such an increase because of the higher number of parents on the weekend according to observation.

Some authors highlight that noise produced by conversations can be positive because it allows the baby to enter the language world, especially when it is the mother's voice<sup>(19)</sup>. However the negative aspect of intense noise caused by conversations when there are a lot of people in the unit is related to inconvenience and stress for the babies and the medical team. That explanation is used to prevent other relatives, including grandparents, from visiting the baby<sup>(20)</sup>.

The study points out that NICU stimulus can distract parents and that their attention turns to the environment rather than to their child; it can decrease their willingness to learn caring skills. It highlights the newborn's ability to interact with noisy settings, which makes parents interpret the baby's reactions as personal rejection and that can cause stress and frustration<sup>(21)</sup>.

On the other hand, frequent high peaks during the night make us think that although they are punctual, they can disturb the newborn's sleep and disorganize the circadian cycle.

The literature shows the deleterious effects of sound pressure high levels to the newborn, such as the increase of irritability and crying, increased intracranial pressure, leading to a possible cranial intraventricular hemorrhage. Besides, higher intake of O<sub>2</sub> and higher heart rate lead to more energy waste and delay weight gain<sup>(8)</sup>.

This study was performed in a NICU macro setting, therefore we cannot be sure that all newborns were exposed to all levels of sound pressure because they were in incubators. The incubator door is opened many times for daily procedures. At those moments newborns are more exposed to environmental sounds in addition to incubator engine noise. It is important to consider that newborns in such micro-environment are also exposed to other kinds of noise when dealing with the incubator such as: opening and closing the door of the bottom cabinet,

elevating and lowering the acrylic dome, placing objects and tapping on it<sup>(22)</sup>.

Some authors mention physiologic and emotional effects on health team professionals, such as: high blood pressure, vasoconstriction, increased catecholamine release, adrenocorticotrophic hormone, cortisol, peristalsis, muscular tension, cholesterol, immune system modification, sleep and mood disorders, fatigue, excitability and hearing loss<sup>(23-24)</sup>. Besides, it is known that noise influences professional's performance by distracting him/her and causing him/her to make mistakes (25-26). The environmental noise in NICUs can be a component which threatens a baby's safety. From that point of view, neonatal intensive care units requires interventions that go beyond technical care.

## CONCLUSION

Considering the sound pressure high levels found in the study and their deleterious effects on newborns and the health team, the results point out the need to include interventions targeting the routine of equipment maintenance and the attitude of relatives and professionals through continuing educational programs. Monitoring of sound pressure levels should be done periodically, in the morning, in the afternoon and at night and on different days of the week.

## REFERENCES

1. Busnel MC. A sensorialidade fetal e suas conseqüências. In: 2 Encontro Brasileiro para o Estudo do Psiquismo Pré e Perinatal; 1994 set 2-5; São Paulo (SP): ABREP; 1997. Anais. p. 9-25.
2. Glass P. O recém-nascido vulnerável e o ambiente na unidade de tratamento intensivo neonatal. In: Avery GB, Flechtcher MA, MacDonald, MG. Neonatologia: fisiopatologia e tratamento do recém-nascido. 4a ed. Rio de Janeiro: Medsi; 1999. p.79-96.
3. Schafer RM. A afinação do mundo: uma explanação pioneira pela história passada e pelo atual estado do mais negligenciado aspecto do nosso ambiente: a paisagem sonora. São Paulo: UNESP; 2001.
4. Standley JM. A meta-analysis of the efficacy of music therapy for premature infant. *J Pediatr Nurs.* 2002; 17(2):107-13.
5. Maschke C, Rupp T, Hecht K. The influence of stressors on biochemical reactions: a review of present scientific finding with noise. *Int J Hyg Environ Health.* 2000; 203(1):45-53.
6. Ribeiro MCS, Bertolozzi MR. Reflexões sobre a participação da enfermagem nas questões ecológicas. *Rev Esc Enferm USP.* 2002; 36(3):300-8.
7. Puccini PT, Cecílio LCO. A humanização dos serviços e o direito à saúde. *Cad Saúde Pública.* 2004;20(5):1342-53.
8. Pereira RP, Toledo RN, Amaral JLG, Guilherme A. Qualificação e quantificação da exposição sonora ambiental em uma unidade de terapia intensiva geral. *Rev Bras Otorrinolaringol.* 2003;69(6):766-71.
9. Ichisato SMT. Ruído em unidade de cuidado intensivo neonatal de um hospital universitário de Ribeirão Preto – SP [tese]. Ribeirão Preto: Escola de Enfermagem de Ribeirão Preto, Universidade de São Paulo; 2004.
10. Noise: a hazard for the fetus and newborn. *American Academy of Pediatrics. Committee on Environmental Health. Pediatrics.* 1997;100(4):724-27.
11. Fasolo MI, Moreira RN, Abatti PJ. Avaliação de nível de ruído em incubadora. *J Pediatr (Rio de J.).* 1994;70(3):157-62.
12. Pereira RP. Exposição sonora ambiental em uma unidade de terapia intensiva geral [tese]. São Paulo: Universidade Federal de São Paulo; 2003.
13. Associação Brasileira de Normas Técnicas (ABNT). NBR 10151. Acústica – avaliação do ruído em áreas habitadas, visando o conforto da comunidade – procedimento. Rio de Janeiro: Associação Brasileira de Normas Técnicas, 2000.
14. Brasil. Ministério do Trabalho, Segurança e Medicina do Trabalho. NR 15 Atividades e operações insalubres [texto na Internet]. Brasília: MS; 1978. [citado 2004 Nov 2]. Disponível em: [http://www.audiologiabrasil.org.br/legislacao/legislacao\\_4.pdf](http://www.audiologiabrasil.org.br/legislacao/legislacao_4.pdf)
15. World Health Organization (WHO). Guidelines for community noise. 4. Guidelines values [text on the Internet]. Geneva; 1999. [cited 2004 Nov 2]. Available from: <http://www.who.int/docstore/peh/noise/Commnoise4.htm>
16. Recommended Standards for Newborn ICU Design. Noise abatement – standards 23. In: Report of the Sixth Consensus Conference on Newborn ICU Design . Clearwater Beach, Florida, Jan. 2006. [cited 2006 Mar 17] Available from: <http://www.sykehusplan.org/data/newbornicustandards1.pdf>
17. Associação Brasileira de Normas Técnicas (ABNT). NBR 10152. Níveis de ruído para conforto acústico – procedimento. Rio de Janeiro: Associação Brasileira de Normas Técnicas, 1987.
18. Robertson A, Cooper-Peel C, Vos P. Peak noise distribution in the neonatal intensive care nursery. *J Perinatol.* 1998;18(5):361-4.
19. Braga NA, Morsch DS. Os primeiros dias na UTI. In: Moreira MEL, Braga NA, Morsch DS, organizadores. Quando a vida começa diferente: o bebê e sua família na UTI Neonatal. Rio de Janeiro: Fiocruz; 2003. p.51-68.
20. Lamego DTC, Deslandes SF, Moreira MEL. Desafios para humanização do cuidado em uma unidade de terapia intensiva neonatal cirúrgica. *Ciênc Saúde Coletiva.* 2005;10(3):669-75.
21. De Paul D, Chambers SE. Environmental noise in the neonatal intensive care unit: implications for nursing practice. *J Perinat Neonatal Nurs.* 1995;8(4):71-6.
22. Rodarte MDO, Scochi CGS, Leite AM, Fujinaga CI, Zamberlan NE, Castral TC. O ruído gerado durante a manipulação das incubadoras: implicações para o cuidado de enfermagem. *Rev Latinoam Enfermagem.* 2005;13(1):79-85.

23. Andren L, Hansson L, Eggertsen R, Hedner T, Karlberg BE. Circulatory effects of noise. *Acta Med Scand.* 1983; 213(1):31-5.
24. Tomei F, Tomao E, Baccolo TP, Papaleo B, Alfi P. Vascular effects of noise. *Angiology.* 1992;43(11):904-12.
25. Thomas KA, Martin PA. NICU sound environment and the potential problems for caregivers. *J Perinatol.* 2000;20(8 Pt 2):S94-9.
26. Carvalho M, Vieira AA. Erro médico em pacientes hospitalizados. *J. Pediatr (Rio de J).* 2002;78(4):261-8.